Regional ITS Architectures and the Competitive Region

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INTRODUCTION

The transportation system of any region is critical for conducting daily operations, sustaining markets, and creating access to new business opportunities. This paper analyzes a role that a system architecture for deploying Intelligent Transportation Systems (ITS) can play in reaching solutions to regional problems. Recent developments in information technologies have implications for transportation institutions by either increasing regional demands for transportation or as catalysts for reaching coordinated regional solutions. The latter option is explored by focusing on why a regional architecture for ITS deployment can be an effective and flexible strategic tool for integrating and shaping a region.

The concept of regional architecture for ITS deployment is presented as an organizational tool that adapts to diverse regional requirements while building cohesiveness among institutions in pursuit of region-specific goals. The case is made for using regional architectures for i) planning ITS deployment; ii) spearheading transportation solutions at the regional level; and iii) and strengthening the metropolitan planning process by bringing stakeholders together that otherwise would not have been included in the process.

RECONSIDERING THE UNIT OF ANALYSIS

Common to our understanding of the word "region" is the image of bounded territory; the existence of a form of social system; members in organizations; shared traditions; and some capacity for developing and implementing policies in pursuit of the region's common goals. However, as the use of information technologies has spread, and the global economy has become more important, profound challenges to institutional frameworks have arisen in many regions. These new developments have influenced how the decision-making authority is distributed among the different levels of governance at the international, national, and regional level. Political and economic roles have changed the pattern of interaction between individual and corporate actors across societies, regions, and nation states. This pattern of interaction is evidenced in the ever-higher number of multi and bi-lateral arrangements and the proliferation of institutions. (1) Regions play a critical role in this new pattern of interaction. Heightened control over economic and political variables together with an increased awareness of the importance of socio-cultural variables have raised the relevance of regions in today's economies. (2)

A shift is occurring from the existence of regions rooted in geographical and political proximity, to regions based on rapidly changing economic interests. Regions are becoming a collection of institutions and members which may be geographically dispersed but share a common economic interest. The fact that economic interests are not confined to strict geopolitical boundaries requires a new, more comprehensive understanding of regions. The next section broadens the concept of region to include more directly how its members and interests change. We call this the "competitive region", defined as a region that is flexible enough to accommodate disparate interests; composed of a changing amalgam of stakeholders; and able to mobilize its changing members towards common goals. (3)

The Competitive Region

Modern regions recognize that global competition is at the heart of their economic success or their failure. The aim of a competitive region is to offer its members access to low cost, quality goods; to provide low-cost resources; and to foster development and regional prosperity. Region-states, involving institutional structures that regulate and promote economic and social activities, are an example of competitive regions. (4) Flourishing areas of economic free-trade agreements, despite a radically different scale than region-states, are another example of competitive regions.

In the debate over regionalism and globalization, a noteworthy assertion put forward is that dynamic regions will increasingly play roles historically attributed to nation states. Kenichi Ohmae

argues that nation states have become progressively dysfunctional in the globalization phenomena. Nation states are less and less representative of community interest and economic activity. Rather, he argues, region-states small enough for their members to develop shared interests, but of adequate size to maintain appropriate infrastructure, have become the linkages in the global economy. (5,6)

The fact that competitive regions have multiple and rapidly changing economic interests, often involving different groups of stakeholders, calls for a new vision of region whose borders may change as economic interests change. As borders shift, so do the groups of stakeholders involved. Each shift involves a change in the institutions, industries, and populations affected. This creates added levels of complexity in addressing regional issues because of the complex interaction between historically rooted institutions and increasingly globalized and dynamic economic agents. (7) [1] This flexibility may also cause a loss in cohesiveness and shared values. The sense of a common mission and purpose is replaced by mixed signals ruled by competitiveness and productivity. As a result, institutions, dealing with overlapping responsibilities and conflicting tasks, may reflect this lost sense of purpose.

Consequences Of The Competitive Region

A new set of barriers to overcome and opportunities to exploit are created when traditional institutions are confronted with the changing economic interests and stakeholders of modern regions. Four characteristics of the competitive region and their planning consequences for the region are summarized in Table 1.

Table 1 Characteristics and Their Consequences on the Competitive Region

THE COMPETITIVE REGION	
CHARACTERISTICS	CONSEQUENCES
Economic interests and the groups of involved stakeholders change frequently. Motivations for stakeholder involvement tend to differ	Planning for regional solutions becomes increasingly difficult
Regional needs and motivations change at a faster rate than societal institutions	Mechanisms to assist institutions in addressing regional issues within the dynamic environment become critical
Borders shift rapidly	Tools are needed for institutional coordination should have a high degree of flexibility mirroring the flexibility of the region
Increased physical communication is required. Intense exchange of goods, information, and knowledge among the networks in the region is critical	A need to support exchange of information and goods in a networked fashion is created

Transportation Planning Implications Of The Competitive Region

Transportation's role of providing access to networks of markets and enabling the negotiation of

[1] Castells draws a distinction between what he calls an "informational society" and an "information society". He argues that the latter, seen broadly as the general communication of knowledge, has been critical in every society. The former, a specific form of societal organization in which information generation, processing, and transmission become fundamental sources of productivity and power, is more closely linked to the current societal and economic transformations caused by technological innovations.

contracts makes it a key component of the competitive region. While transportation has always been important in regional development, each of the consequences presented in Table 1 has extended implications for the planning and management of transportation systems. These can be extended from the discussion above:

- Given the diversity of regional interests, their changing nature, and the multi-jurisdictional character of transportation services, some level of regional coordination and cooperation of transportation activities, e.g., planning and operations, is desired.
- Planning for regional transportation services has become increasingly difficult mostly due to the multiplicity of stakeholders and borders, and their dynamic nature.
- With the development of information technologies, managing a transportation system involves the handling of substantial information in addition to the traditional management of infrastructure and flows. These technologies have created new roles for transportation institutions, such as information management and dissemination, that can help them better address the planning challenges of the competitive region.
- Either existing arrangements for institutional (private and public) planning coordination be modified or new tools be developed in order to address this growing and diverse group of regional stakeholders.[2]

A primary hypothesis of this paper is that a system architecture, while guiding the deployment of ITS, is further proposed as the instrument to address the regional transportation planning and coordination needs implied by the competitive region. A forum for integrated cooperation and coordination would reclaim the cohesiveness of region and bring stakeholders together around transportation issues.

The next section introduces the concept of system architecture in the context of ITS. It then expands on the role of a system architecture by explaining how it addresses the components of the competitive region. The architecture is presented as a tool for assisting in technology deployment; as a facilitator for initiating dialogue between stakeholders; and as a mechanism for improving institutional flexibility and responsiveness.

AN ARCHITECTURE FOR DEPLOYING ITS

Significant advances in ITS applications have occurred in response to the need for improving the operating efficiency of transportation systems and as a result of the limited possibility of physically expanding transportation infrastructure. In the context of urban transportation systems, for example, ITS can address problems such as traffic congestion, toll collection, safety, and the adequacy and quality of surface transportation information made available to the traveler. (8)

A system architecture is a design tool used to develop compatible systems over long time periods, improve stakeholder cooperation, reduce complexity, and address some institutional concerns associated with deploying large-scale complex systems. Deployment of interoperable ITS projects in a region over an extended period of time requires a substantial level of cooperation among entities in charge of managing traffic, operating public transportation, providing traveler information, and building and maintaining infrastructure among others. Therefore, a system architecture is judged to be a useful mechanism for ITS development and deployment and indeed, a national ITS architecture has been a major initiative of he federal ITS program.(9)

[2] In other research, we found that traditional transportation planning and technology deployment efforts were neither coordinated nor inclusive enough to encompass what some regions considered to be their transportation priorities.(13)

Definition of System Architecture

A system architecture for ITS guides the technology deployment process by allowing better transportation agency and user choices, facilitating service integration, and encouraging market competitiveness. (10) In this context, a system architecture can be defined as a

> *framework around which the major transportation system elements interact to achieve system goals. It provides a description of the elements and the interconnections among them.*

An area of research discussed elsewhere is the development of regional architectures for coordinating ITS deployment based on a broader and more encompassing architecture, for example a National ITS Architecture in the US. (11) Regional architectures address localized transportation needs while enabling regional coordination and cooperation by using the National Architecture as a base.

However, a regional ITS architecture can, and we argue *should*, go beyond its technology deployment orientation. Traditionally, systems engineers have thought of architectures as solely technical documents depicting sub-system interaction and design. Since ITS deployment involves coordination, new information flows, and sharing common goals and new relationships between the public and private sector, we argue it could be pro-actively used for re-shaping institutional roles in the region.

Regional ITS Architectures And The Competitive Region

If the broader functions (in addition to being a blueprint for ITS deployment) of being an integrator for spearheading regional transportation solutions are assigned to a regional ITS architecture, we then can argue that a regional architecture can address needs implied by the competitive region. First, a regional architecture provides the flexible coordination necessary in the management and operation of a transportation system. Second, it becomes the backbone of information exchange among related to transportation institutions and users. Third, since an architecture can encompass different scales, for example a local or a national architecture, it can be tailored according to regional needs and desired coverage within a common framework that promotes system compatibility. And finally, ITS deployment gathers not only transportation agencies, but also planning agencies, development agencies (as in Fairfax County, Virginia), individual users, private equipment suppliers, and freight shippers and carriers. Traditionally, metropolitan transportation planning has been weak in involving the private sector in the planning process. Hence, with its proposed strategic character, a regional ITS architecture becomes a mechanism for improving the traditional transportation planning process. (12)

The above represent an ambitious role for a regional ITS architecture. Indeed, to date the role of regional system architectures, with few exceptions, have been used to accommodate regional transportation trends in a reactive manner and within existing tight institutional constraints. (11) Because there is ample evidence that transportation institutions tend to be reactive and slow to change, an ITS system architecture should be presented as a potential stimulus for jump-starting innovation and anticipating future regional transportation challenges. We argue that an architecture simply mirroring existing institutions and bounds is giving up a chance for innovation and change, associated with the consideration of new information-intensive transportation systems.

Table 2 provides a summary of why a regional ITS architecture can be an effective medium for addressing the needs created by the competitive region.

Table 2 Features of a Regional ITS Architecture Relevant to Competitive Regions

In addition to its role as ITS deployment guide, a regional architecture is an information sharing mechanism that allows improved interaction between transportation institutions and regional economic stakeholders
It provides a forum for integrating stakeholders, such as freight shippers and carriers, that have a vested interested in having an improved transportation system and that are seldom addressed in the metropolitan planning process
From the two entries above, it follows that an architecture provides a framework for regional cooperation for the planning and operations of transportation systems
It is a tool suited for broadly and narrowly defined regions because it can vary in scope. As regions change, an architecture can be redefined
It can be helpful in reducing institutional complexities implied by the competitive region

MENDOZA, ARGENTINA --AN ILLUSTRATIVE EXAMPLE

A useful illustration of many of the concepts discussed thus far is the Province of Mendoza, Argentina. Mendoza, a largely agricultural area, which borders the Andes Mountains. The provincial capital city of Mendoza is proximate to Santiago and Valparaíso, Chile. The former is the major market in Chile; the latter is a major Pacific-Rim port. The Province has an area of close to 150,000 square kilometers and a population over 1.4 million (13). Growing international trade and the expansion of the Mercosur trade agreement, which includes Argentina, Chile, Brazil, Uruguay, Paraguay, and Bolivia, provide a great potential for future economic growth in Mendoza. Exports in the Mendozan economy have increased steadily in recent years adding up to US $ 784.5 millions in 1996. Of this, 31% corresponds to fuel and energy related exports, 27% to manufactures of agricultural and cattle origin, 26% to manufactures of industrial origin, and the remaining 16% to primary products (mainly vegetables and fruits). (14)

The transportation network in Mendoza includes national, provincial and urban highways, railroads, and intermodal terminals. The rail and highway networks are the most important elements of the freight transportation system; trucks are responsible for the majority of the freight movements within the Province. Two major roles for the rail network that have been identified are: i) East-west long distance movements of bulk freight, and ii) the movement of intermodal containers between Mendoza, and Buenos Aires. (15)

With the development of Mercosur, the idea of a Bi-Oceanic Corridor from Rio de Janeiro, Brazil and Buenos Aires, Argentina to Santiago and Valparaíso, Chile, including a low-altitude railroad tunnel through the Andes, and passing through Mendoza, as shown in Figure 1, is under discussion. The Bi-Oceanic corridor would integrate the Mercosur nations and provide Pacific-rim access for those partners east of the Andes; this gives Brazil and Argentina, and Mercosur as a whole, better access to the west coast of North America and to the emerging markets of Asia as well as to each other.

Traditionally the sense of Mendoza as an independent region had been shaped by geographic considerations, mainly its bordering on the Andes and its isolation from the nation's capital, Buenos Aires more than 900 kilometers to the east. This sense is changing; economic globalization, the integration of Mercosur, and the strategic position of the province in the Mercosur trade context has generated a sense of a competitive region. In this new regional framework, the economic ties and partnerships can involve not only Buenos Aires and the rest of Argentina, but also Santiago and Valparaíso in Chile and parts of Brazil.

While the trans-Andean tunnel is a key element of the Bi-Oceanic Corridor, Mendoza needs an improved transportation system to support the tunnel and the Bi-Oceanic Corridor. The research question here is how can the concept of a regional system architecture be useful in the development of this

transportation system; and to determine what are the major considerations and tradeoffs involved. This application represents another challenge for the architecture approach because: i) the province of Mendoza is largely rural in nature, while most other cases studied have had an urban flavor; ii) the driving force behind the upgrade to the transportation system is the movement of freight while most other cases have emphasized passenger movement; iii) the "region" involved can be defined at various levels: urban, provincial, national, and international while other cases of architecture development have had a fixed notion of region as their base; iv) Mendoza can be characterized as a developing competitive region while other architecture applications have been in highly developed regions; and v) it is not clear at the outset whether ITS investment is cost-effective.

Figure 1. South America, Mendoza, and the Bi-Oceanic Corridor (14)

The Massachusetts Institute of Technology (MIT), working together with colleagues at the Center for Technological Innovation (CIT in Spanish) in Mendoza, is developing a strategic plan for a multimodal freight transportation system in the province. We have argued that a regional architecture can be a fundamental component of such plan because:

- A system architecture can be a blueprint for institutional planning across the various scales of region. Even without an actual initial deployment of ITS, an architecture maps how information will be arranged among institutions in the region and how these institutions interact in achieving their functions.
- Freight transportation and international trade play a critical role in the development and prosperity of the province. A system architecture provides a specific framework for integration of the rail and truck modes and provide impetus for their development in the region.
- The Bi-Oceanic project will face a complex jurisdictional and institutional context. A tool for coordination and integration will help in understanding the tradeoffs and main issues related to the

corridor project.

- An architecture can draw attention to the importance of having a systematic transportation planning process for the region. By bringing economic regional stakeholders together, the architecture is providing a basis for planning activities to develop in at least two ways. First, an architecture can act as a catalyst to draw stakeholder attention to transportation planning functions. Other catalysts that affect planning can include, for example, community unhappiness with planning outcomes or new legal requirements imposed by some level of government. Second, by mapping how information is or will be exchanged among institutions, an architecture uses information exchange as a region-wide institutional planning and coordination tool. We have reported elsewhere that Houston's experience with a regional architecture went beyond the traditional architecture role of coordinating ITS deployment mostly due to its information and coordination functions. In Houston's case the architecture became an overarching regional transportation integrator[3]. (11)

An ITS Architecture for Mendoza's Freight Transportation System —Key Considerations

Multiple tradeoffs specific to Mendoza are involved in defining the scope of coverage of a regional architecture

Determining the scope of the regional architecture is associated with defining the region of interest. In the broadest sense, the region could be conceived at the Mercosur bloc level with Mendoza being a participant like any other province in the region. In this conception, the Bi-Oceanic corridor would be *an important*, but not *the only* transportation link in the region. In a narrow sense, the region could be defined at the level of the province of Mendoza with a portion of the Bi-Oceanic corridor included within the Mendoza region. An intermediate point between the two is to define the region as the Bi-Oceanic corridor involving the tunnel crossing, Mendoza, Santiago and Valparaíso. The scope of the latter definition of region is more closely aligned with the notion of competitive region than the two former definitions because of the economic interests and motivations underlying the Bi-oceanic corridor.

Although appealing, defining an architecture with the broadest scope possible creates substantial institutional complexities in its design and implementation. Issues such as coordination and autonomy will be amplified due to the international nature of the actors. A narrowly defined architecture may limit the benefits to freight users and suggests a higher risk that neighboring areas develop incompatible systems in the future. Clearly, there are advantages and disadvantages in the various architecture concepts.

Mendoza faces particular financial, economic and institutional constraints to applying the ITS architecture concept

Scale of coverage, financial commitment and economic stability are basic features covered when addressing a regional architecture. Needless to say the structural unpredictability of factors such as finances and economic performance, in addition to the institutional complexities associated with multiple jurisdictions, constrain the application of new technologies like ITS in Mendoza. These constraints will limit the scope and functionality of an ITS architecture for the region.

Strengthening of local transportation planning functions

Any action taken to strengthen local planning functions is welcome. The ability to anticipate

[3] Houston's architecture has a regional strategic character because it created a vision for the region's transportation system and highlighted its relevance to the region's economic well-being while re-defining institutional transportation roles in the metropolitan area by co-locating multimodal operations and control centers under one facility.

future events allows for a planned response that can move the region closer towards achieving its developmental goals. In this respect, a system architecture can be a particularly strong force for bringing stakeholders together. Further, Mercosur's future relevance in an increasingly important hemispheric trade environment may place Mendoza in the international spotlight. By supporting and enhancing information sharing and coordination, a system architecture stimulates the necessary networking effects observed in competitive regions worldwide. (16)

Need for human resource training component

A basic local layer of knowledge is particularly important when targeting the transportation coordination and information sharing activities assigned to a regional architecture. Such layer is even more important when an architecture is considered in the context of a developing country. The layer should include all the expertise requirements of the system. Although the emphasis is on technology and transportation, it is also necessary to provide knowledge on other fields such as management science, international trade, and international law. Appropriate training and education of human resources, research at local institutions, technology scanning, and technology transfer issues are central to develop this knowledge layer.

Despite potential private sector participation due to freight's importance, Mendoza's public sector leadership is needed to develop an integrated ITS system

Assuming that freight carriers individually adopt technologies that provide net benefits to their operations, achieving some level of system compatibility and integration is desirable. Administrative paperwork at border crossings, toll collection, and weigh-in-motion are a few services in which public sector leadership and coordination is needed *in conjunction* with private sector participation. To this end, the development of a system architecture constitutes a substantial commitment from the public sector. The public sector's adoption of a system architecture is a step that constitutes a strong commitment towards ITS deployment. Private shippers and carriers will be more willing to participate in the Corridor Project once this initial step is taken, thereby enhancing the overall feasibility of the project.

The province of Mendoza lacks previous ITS related experience

On the one hand, the lack of ITS experience means that any deployment has to overcome an initial "learning curve" related to the introduction of new technologies. This refers not only to human resources, but also to political and technical knowledge on how to best achieve effective ITS deployments. On the other hand, a "green field" can be a source of flexibility. Contrary to many urban areas in developed countries where ITS deployment has occurred, Mendoza is not constrained by existing systems and interoperability problems.

A Regional System Architecture For Mendoza

In analyzing the potential of a regional ITS architecture for Mendoza, we considered three critical architecture aspects[4]: i) scope of coverage; ii) public and private sector orientation; and iii) command and control or information and advisory architecture. These aspects are important because making a choice among them entails fundamental institutional tradeoffs and defines the set of potential advantages that an ITS system architecture, can bring to the region. Better understanding of tradeoffs enlightens the decision-maker's perspective. We argue that the development of an ITS architecture well in advance of

[4]Architecture a*spects* are defined as technical and institutional questions about the regional architecture. From an institutional perspective, aspects involve strategic questions such as "what level of inter-agency cooperation is desired and what level is feasible? " or "should all surface transportation modes be included in the system architecture?"; for further details, see (13).

potential ITS deployment can serve as coordinator for regional transportation planning.

Scope of coverage of the architecture

From a purely practical perspective, consideration of the current institutional complexities associated with Mercosur suggests that Mendoza should propose its own architecture, and the scope considered should be the province itself. Two reasons prompt this conclusion. First, after reviewing the institutional issues of metropolitan areas studied in earlier works, we found that complexities in metropolitan areas, although imposing, were certainly less than the institutional intricacy of a multinational trade alliance like Mercosur. Second, Mendoza's current transportation institutions and planning practice suggest that an incremental approach towards the architecture that focuses on addressing the Province's pressing needs first before engaging in broader discussions with neighboring countries would be more appropriate.

The consequences of defining a regional architecture at the province level due to institutional constraints are substantial. First, the province will be limiting the initial institutional benefits (and costs) to its jurisdiction.[5] Second, defining the region in terms of *jurisdiction* rather than *economic motivation* implies that institutional constraints do limit the development of the competitive region. By developing an early system architecture, Mendoza would build regional expertise in ITS system coordination and prepare its institutions for integration with the broader competitive region. Further, the flexibility that should characterize regional ITS architectures suggests that the scope of the architecture can be changed as needed. And finally, the jurisdiction-based definition of region used as a starting point can dilute the overarching importance of freight transportation and tilt the scales towards ITS services unrelated to freight. To avoid this, the province should continue to have a vision of freight's importance for the province's economic well-being and a clear understanding that the scope of the architecture suggested here is an *initial* step of a broader architecture in support the Bi-oceanic corridor.

Although this approach cannot guarantee the province's prominence in Mercosur, it will enhance Mendoza's position and guide its strategy in national and international deliberations about the corridor.

Public Sector and Private Sector Orientation

Due to the importance of freight transportation in Mendoza, any attempt to overhaul the transportation system should fully consider freight carriers and shippers. ITS freight services supported by the architecture, from the carrier's perspective, focus on vehicle and driver scheduling, monitoring, and routing. From the public sector's perspective, in contrast, expediting administrative paperwork, safety regulation enforcement, and tax collection are key motivators. Therefore, public and private sector ITS functions associated with freight transportation would be cornerstones of a regional architecture.

Interesting institutional and architecture design questions arise. On the one hand, ITS freight users would comprise a collection of tens or hundreds of individual (transnational) companies. These distributed users would be using multiple ITS services individually over a large area, perhaps comprising even multiple countries. Therefore, some degree of decentralization is clearly desirable. On the other hand, border transactions necessitate some degree of data coordination, at the highest level among countries, and at a low level, among checkpoints along a specified route.

Command and Control or Information and Advisory

An ITS system with multiple users spatially distributed is unlikely to gain broad acceptance if the locus of decision-making and control lies on a single or few institutions. The potential for involvement of

[5] User benefits, however, can still spillover beyond the region. International freight carriers using the Bi-oceanic corridor, for example, may realize that the functions enabled by the architecture are beneficial to their operations.

other countries in ITS services, and by extension, in the architecture, further complicates a command and control architecture. Rather, scheduling and routing control at the individual (firm) level appears to be politically and functionally feasible. Besides supporting administrative freight services, the ITS system can also provide information about the Bi-Oceanic corridor, particularly about incidents, congestion, alternative routing and other relevant information.

The focus on information distribution and coordination raises questions about possible complementarities between an information infrastructure and an ITS infrastructure. Possible complementarities between the two can be more directly exploited since the region has had very limited experience with ITS and an information infrastructure. The main tradeoffs related to the architecture aspects discussed above are summarized in Table 3.

Table 3 Architecture Aspects and Their Tradeoffs for the Mendoza Region

Architecture Aspect	Architecture Aspect of Choice	Tradeoffs Involved
Scope of Coverage	Province of Mendoza	• Less institutional complexities; higher speed of design and implementation • Province controls process; an incremental approach • May become freight unrelated and lose its economic-based motivation
Public/Private Sector Orientation	Private Sector-Based; with Public Sector Transactions	• Market orientation of the architecture • Need to define the degree and format of public sector interaction with transportation providers/clients • Decentralized end-users
Information and Advisory /Command and Control	Information and Advisory	• Eases acceptance of the architecture • Allows for complementarities with information infrastructure • May lack benefits of full coordination and integration provided by a centralized command structure

The Province of Mendoza has been depicted as a strong and emerging area featuring characteristics indicative of a developing competitive region. The Province relies, and will continue to rely, on the importance of geography and politics, key components of a traditional notion of region. Paradoxically, Mendoza's geographic location is stimulating the leap towards becoming a competitive region. The interest in improving the Province's ability to compete better in the global economy, by carving a niche in the freight transportation services market, has created features of a developing competitive region.

The previous sections outlined the concept of a regional architecture for the Province of Mendoza, based on providing support for a Bi-Oceanic Corridor integrating the Mercosur trade agreement. As an architecture application, this differs substantially from current work focused on developed urban areas. Yet, it appears that the basic principles of architecture development still apply. Further, since Mendoza is a developing competitive region with national and international ties, it provides a useful laboratory for an expanded notion of regional architecture in support of flexible and interoperable transportation systems.

CONCLUSIONS

A more encompassing way of defining the concept of "region" is useful for dealing with global economic competition. The general concept of region exists in different scales yet always retaining a fundamental economic-based motivation. Such economic motivation calls for improving the efficiency of regional operations. Transportation is an integral component of the notion of a competitive region.

Within transportation, ITS has moved to the forefront as an application that can continue to revolutionize the transportation field and the notion of region; it serves as a regional integrator of transportation systems and services. Further, an ITS architecture can serve as a framework for regional transportation strategic planning. ITS deployment constraints are fundamentally institutional in nature because institutions are anchored in the specific geopolitical conditions in which they were created. The definition of regions, in contrast, is inherently dynamic; varying mainly according to economic interests. Granted, institutional missions change over time, but change is not easy. A sudden mission change that steers an organization away from its original intent diffuses support and weakens institutional cohesiveness. (17)

A key problem was therefore identified, and a proposal for coping with it developed: regions need to find mechanisms to manage their changing boundaries and composition. *The regional system architecture for ITS frames transportation solutions in terms that can change over time.* On the one hand, the regional architecture's institutional foci strengthens inter-organizational and inter-jurisdictional planning and implementation for ITS. The flexibility in the scope of the architecture makes it unique for coordination of ITS deployment and that of conventional infrastructure as well, when intermodal exchanges are considered. On the other hand, the simplicity of developing a regional architecture allows for its regular redefinition as conditions or the scope of regional interests change, as suggested in Mendoza's case study.

Finally, as the emphasis on regional competitiveness increases, the importance of having a true regional blueprint showing the possibilities for assisting in solving regional transportation problems increases. In fact, one of ITS' fundamental strengths lies in its ability to address diverse transportation challenges, from enhanced mass transit operations to improved safety on rural roads. *The challenge lies in utilizing a regional architecture to coordinate regional deployment in the context of specific regional goals and objectives by facilitating appropriate institutional change.*

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